Reconstructing the Z peak in **Z->**tt a generator-level study

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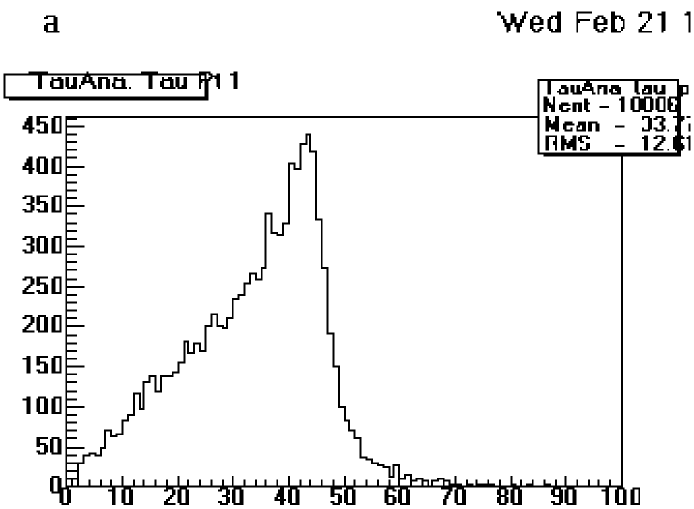
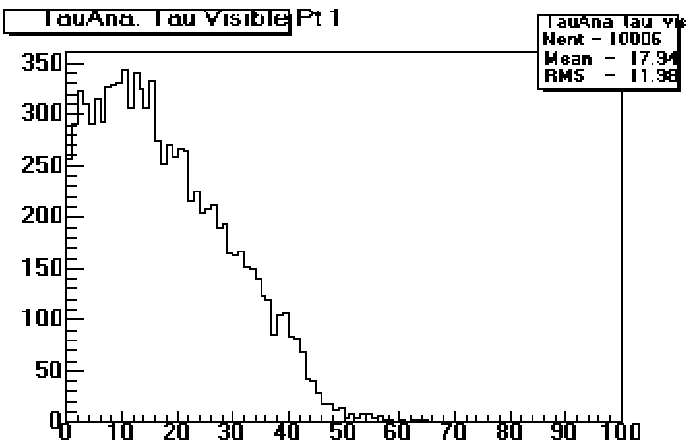
- **Introduction**
  - One can do feasibility studies at different levels:
    - Generator-level
    - Using reconstructed MC data
    - Using the real data
  - One of the issues with the generator-level studies is that it is easy to "over-interpret" the results. Generator-level studies often ignore the real resolutions, reconstruction efficiencies, so it is important not to be trying to conclude more, than the method allows
  - What one can learn at this level:
    - Check the method, see if it works at all
    - See what is the intrinsic resolution of the method
    - Determine upper limits for the efficiencies
  - In addition, I'll also discuss (at a very preliminary level) the expectations for the summer'2002

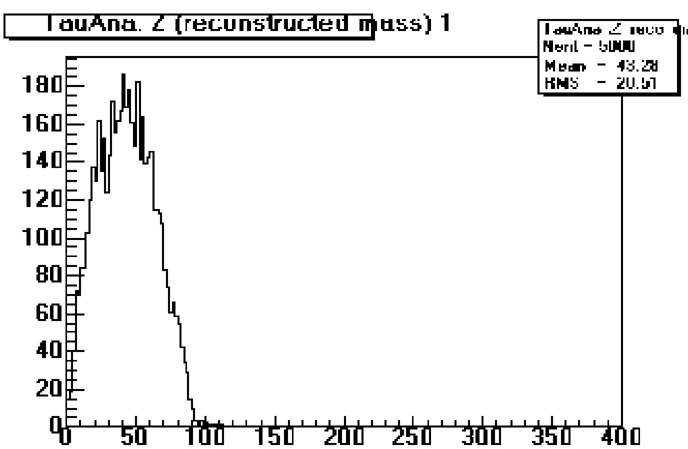


Pt spectrum for Z->ττ is a typical for 2-body decay Pt-spectrum



As there is always 1 or 2 neutrinos in τ decay, the visible Pt is very different from the one above

And, consequently, the distribution for the jet-jet (lepton-jet) effective mass doesn't show a peak



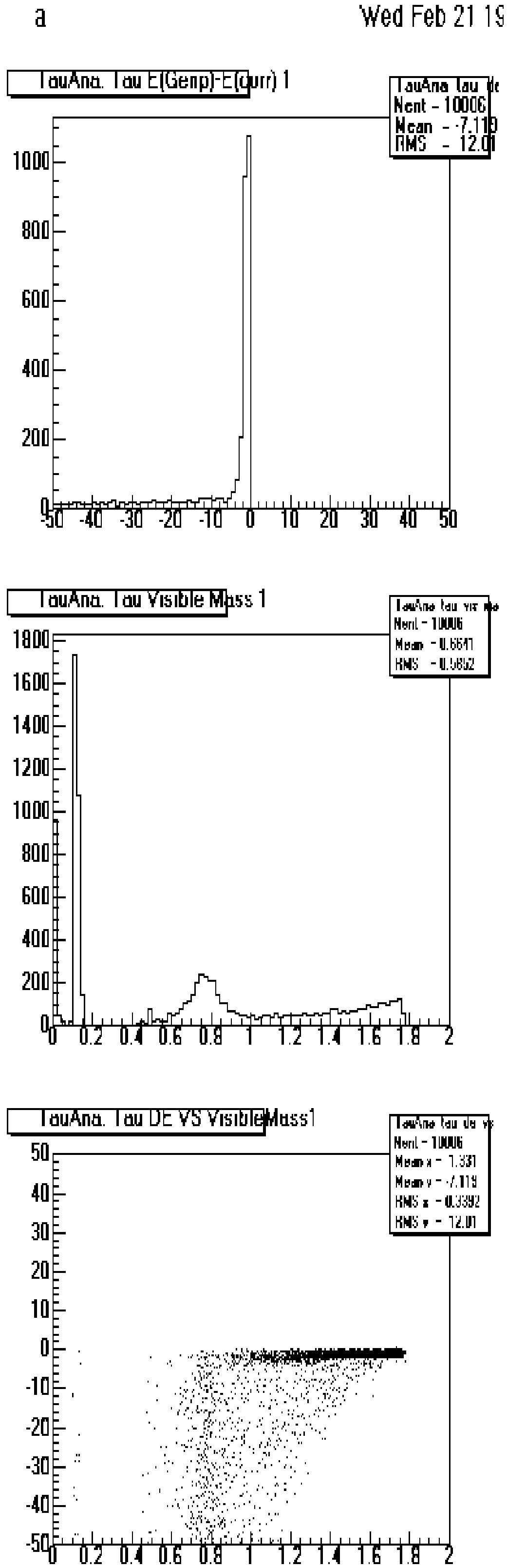
However one can try to reconstruct a missing neutrino...

- The idea is fairly simple: let’s ignore the transversal momentum of the tau daughter in tau decays: M(tau)/P(tau) << 1
- Then one can use a mass constraint to reconstruct the missing neutrino:

$$(E_{vis} + \varepsilon_\nu)^2 - (P_{vis} + p_\nu)^2 = m_\tau^2$$

$$p_\nu = ((\frac{m_\tau}{m_{vis}})^2 - 1)(E_{vis} + P_{vis})/2$$

- Where Mvis is an effective mass of the reconstructed tau daughters and Evis, Pvis are their effective momentum and energy
- Doesn’t work well when M_vis<<M_tau, meaning that it is not applicable to leptonic tau decays
- Need to see how it applies to the hadronic decays



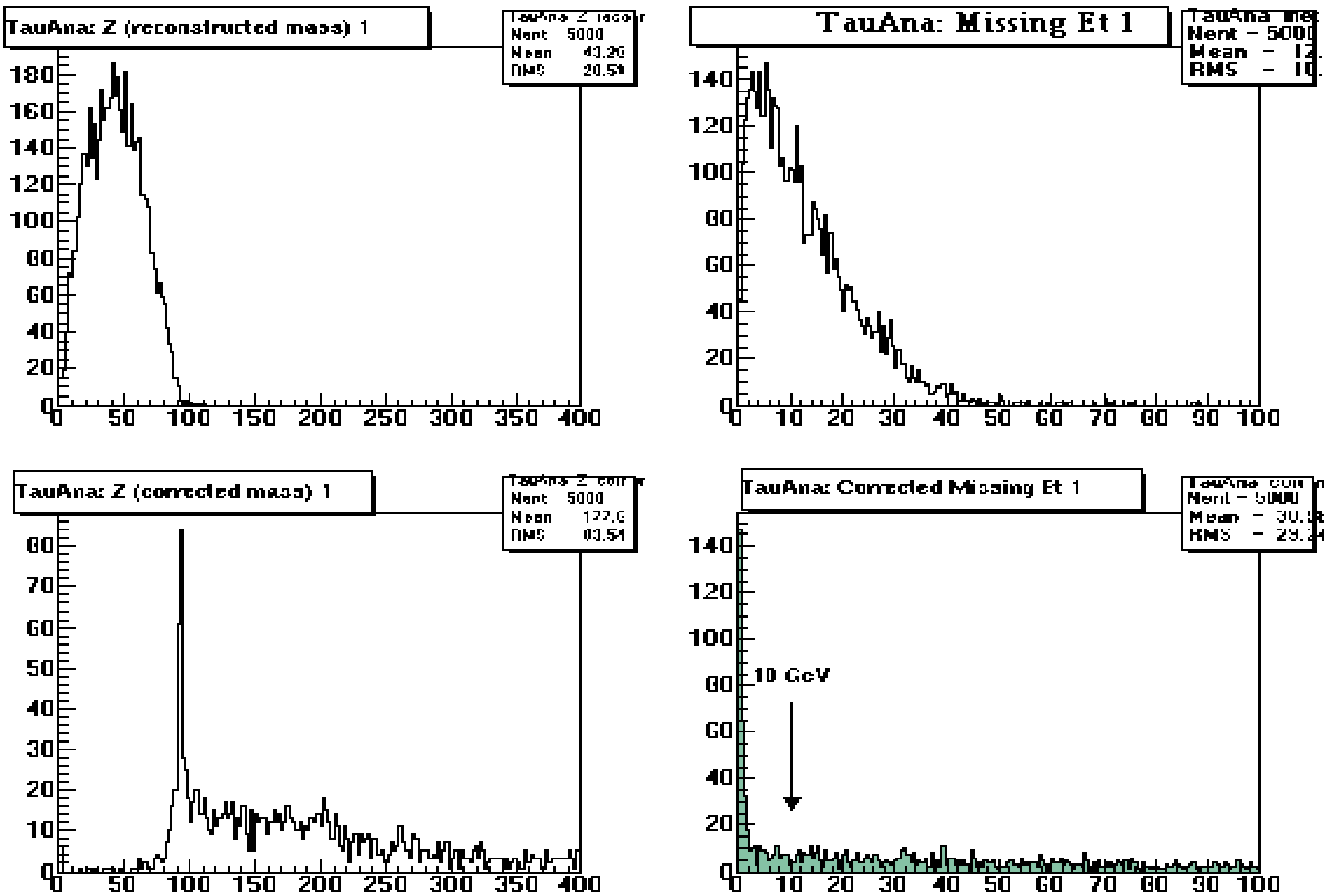
The distribution for the corrected energy shows that there is a kinematic region, where the correction technique works quite well

It is worth noting that neglecting the transversal momentum in tau decays always leads to overcorrection – the corrected energy of the tau-lepton is always larger than the true one

The distribution for the visible tau mass – effective mass of the “reconstructed” daughters

As one could expect, at large masses (Mvis > 1GeV) the correction technique works, or (in more safe wording):

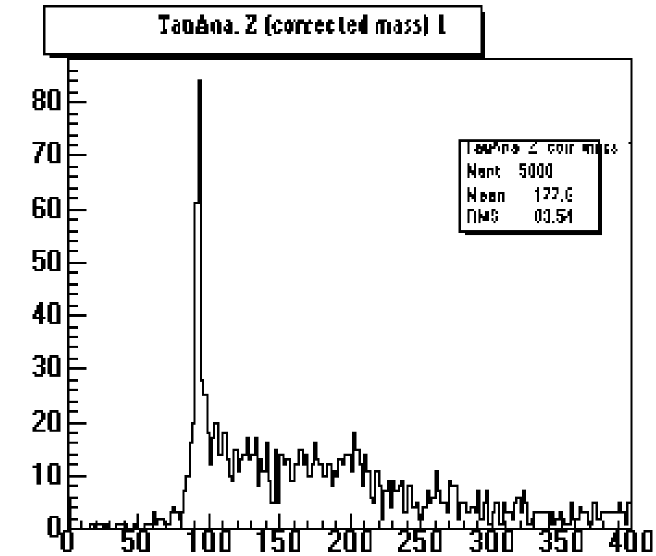
One shouldn’t expect it to work well below 1 GeV



When correcting the tau momenta, one also corrects missing Et. This can be used in several ways:

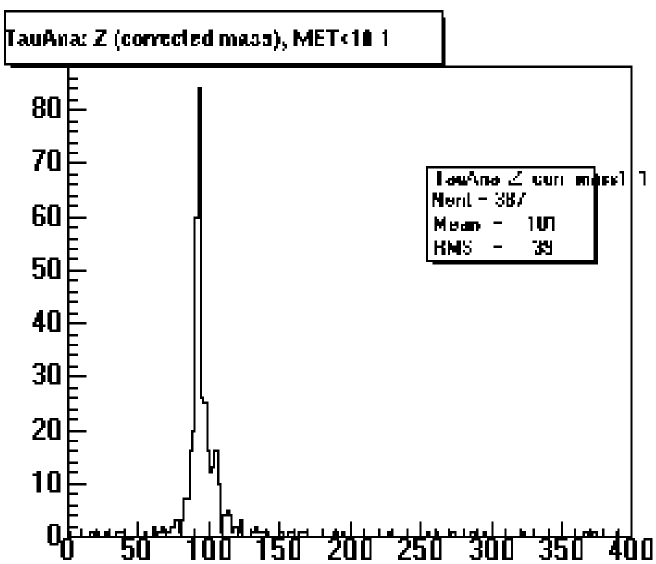
One can cut on missing Et, for example, require MET < 10 GeV (CDF resolution in MET was about 3GeV in Run I)

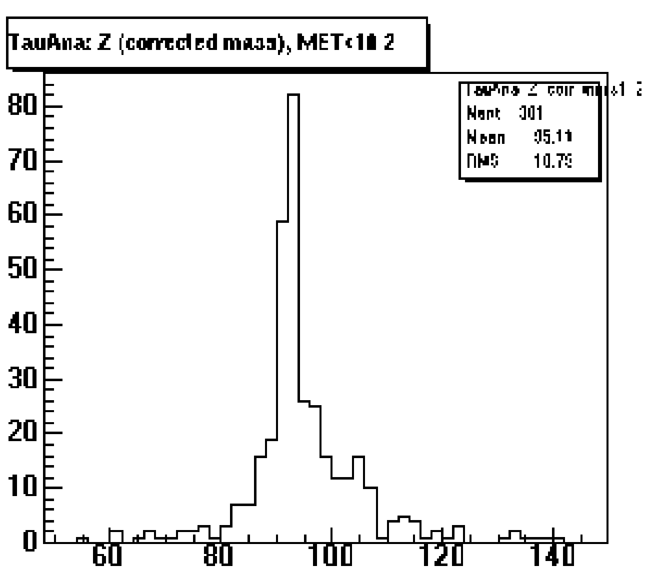
MET=0 requirement can be put as a constraint into the kinematical fit and define corrected momenta out of the fit



As this is a generator-level study, to see what is the effect of using MET information could be, I just cut on it, requiring MET < 10 GeV

The resulting distribution is shown in the middle slide





Resulting peak, zoomed
Both tau's decaying hadronically
The peak is clearly non-gaussian, however it's central part has its width close to the natural width of the Z-boson

- **5000 Z->tau tau events total simulated,**
- **in about 40% of them (2000) both tau's decay hadronically**
- **A little bit less than 20% of those stay in the peak**
- **This is an upper limit, phrasing it accurately one shouldn't expect more than 20% of all the events**
- **Te number of 20% means that in about 40-45% of all the cases the momentum correction procedure gives the right answer (again, "it works, and the upper limit is about 40-45%")**
- **So one can use Z->tau tau events with one tau-lepton decaying hadronically and another one – in lepton mode to reconstruct Z peak as well. In this case the resolution will be defined by the resolution in missing Et**
- **The correction procedure works well if Mvis is large enough (Mvis > 1 GeV), so nominally, there even is a room to accommodate some inefficiency**
- **At this point one can start asking questions:**
  - What is the effect of pi0 reconstruction? How does it affect the results?
  - What is the impact of experimental resolutions? Would they kill the peak?
  - … and many others

- **If we ignore pi0’s at all and use only 3-prong decays of tau’s (which account for about 25% of all the hadronic decays) and assume that for these the reconstruction efficiencies are OK and they all will stay in the peak (the visible mass is large), we are left with 1/16 of all the hadronic events**
- **Estimates from CDF-4718:**
  - 2fb-1: about 16000 Z->$\tau\tau$ events with both tau’s decaying hadronically
  - The reference number for the summer’2002: 300pb-1, meaning about 2500 events
  - 1/16 of those is something like 160 events
  - 1/5 is about 500 events
- **If by the summer of 2002 we have a chance to see about 200 events in the Z-peak, this analysis seems to have a clear and well-defined goal!**